The USDA Quince and Pear Genebank in Oregon, a World Source of Fire Blight Resistance

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Abstract

The U.S. Department of Agriculture (USDA), Agricultural Research Service (ARS), has operated a genebank for temperate fruit and nut crops in Corvallis, Oregon since 1981. This facility, the National Clonal Germplasm Repository (NCGR), is devoted to conservation of many rosaceous species that are potential hosts for fire blight (*Erwinia amylovora* (Burrill) Winslow). Globally diverse collections of *Amelanchier*, *Cydonia*, *Mespilus*, *Pyrus* and *Sorbus* germplasm have been assembled at the Corvallis genebank. Unique genotypes are maintained as growing plants, evaluated for phenotypic and genotypic traits, tested for virus contamination, documented in a national public germplasm database and freely distributed to international researchers. Seed collections represent wild species populations. The NCGR *Cydonia* collection includes more than 100 clones and 14 seedlots from 15 countries. Fire blight resistance has not been documented in the *Cydonia* germplasm; however, many recent introductions from the quince center of origin in central Asia and the trans-Caucasus region have yet to be evaluated. The NCGR *Pyrus* collection includes 2030 clonal pear accessions and 327 seedlots representing 36 *Pyrus* taxa from 53 countries. More than 160 pear clones are identified as being highly to moderately resistant to fire blight. Temperatures in western Oregon's Willamette Valley are normally below the threshold necessary for spread of fire blight during *Cydonia* and *Pyrus* bloom periods, and the weather is dry in the summer, making NCGR-Corvallis an ideal location to preserve these living germplasm collections for future generations.

INTRODUCTION

The USDA-ARS National Plant Germplasm System (NPGS) operates 8 genebanks to preserve genetic resources of important fruit and nut crops. The NPGS mission includes acquisition, documentation, preservation, evaluation, enhancement and distribution of plant genetic resources (Postman et al., 2006). The National Clonal Germplasm Repository (NCGR) in Corvallis, Oregon maintains major collections representing word diversity of *Corylus, Cydonia, Fragaria, Pyrus, Ribes, Rubus* and *Vaccinium*. Smaller "minor" collections of *Amelanchier, Chaenomeles, Crataegus, Mespilus, Sorbus* and about 20 other genera are also maintained. Several of these genera belong to subfamily *Maloideae* of the Rosaceae and have members that are highly susceptible to fire blight. The climate in western Oregon is not conducive to the spread of fire blight and therefore susceptible genotypes can be safely maintained in field collections at Corvallis with little risk of loss due to this disease.

RESULTS AND DISCUSSION

Cydonia Germplasm Collection

The NCGR *Cydonia* collection includes 105 clones and 14 seedlots from 15 countries (Table 1). Clonal quince accessions are maintained as self-rooted trees in a field

collection, and seedlots are stored at -20°C. The clonal collection includes 41 cultivars that are used for fruit production in different parts of the world. Additional clonal accessions represent pear rootstock selections, wild types and seedlings. As self-rooted trees, the clonal integrity of the accessions will not be compromised by rootstock suckers from a different genotype.

Pyrus Germplasm Collection

The history, maintenance and composition of the NCGR *Pyrus* collection was recently reviewed (Postman, 2008). Clonal accessions are grafted onto OHxF 333 rootstock and maintained as one tree per accession in a field collection. More than 325 seedlots stored at -20°C represent wild *Pyrus* species diversity, and seedling populations grown from many of these seed collections (5 seedlings per seedlot) are established in a field planting to verify taxonomy, evaluate for phenotypic traits and potentially regenerate seedlots through controlled crosses within populations. Non-hardy pear genotypes are duplicated in a potted greenhouse collection. In vitro shoot cultures are also stored as backups for about 10% of the clonal collection at 1 to 4°C, and apical meristems from about 100 clones are cryogenically stored for longer term backup (Reed et al., 2004). The 2031 clonal pear accessions and 327 seedlots represent 36 *Pyrus* taxa from 53 countries (Table 2) (Postman, 2008) and include 860 European and 150 Asian cultivars. More than 75% of the cultivar accessions at NCGR are available as virus tested plants. This is the result of on-site virus assays and pathogen clean-up procedures (Postman and Sugar, 2002; Postman, 2008). Microsatellite markers are used to generate a molecular fingerprint database for clonal identity verification and elimination of redundancy (Bassil et al., 2005, 2006).

Recent _Cydonia_ and _Pyrus_ Acquisitions

Recent seed and plant importations have expanded the global representation of *Cydonia* and *Pyrus* germplasm conserved at the genebank. The region around the Caucasus Mountains in central Asia is considered to be the center of origin and a source of great genetic diversity for wild-type European pear and quince (Vavilov, 1994). DNA analysis of wild pear seedling populations using microsatellite markers suggests that there remains much untapped pear genetic diversity in this region (Volk et al., 2006). Collecting expeditions to Armenia, Georgia and Turkmenistan in recent years have added important wild-collected samples of *C. oblonga*, *P. communis* ssp. *caucasica* and P. *salicifolia* from this center of origin to the genebank holdings. These recent accessions expand on the pear and quince genetic diversity from Russia, Turkey and Ukraine that was added in the 1970s and 1980s (Table 1 and 2). While North American pear breeders have had access to a wide diversity of the world's *Pyrus* germplasm (Bell, 1990; Bell et al., 1996), the diversity of available *Cydonia* germplasm has been very limited until now. Only a dozen fruiting cultivars were registered by the American Pomological Society from their founding in 1848 through 1997 (Postman, 1997).

Fire Blight Resistance in _Cydonia_ and _Pyrus_ Germplasm

Because fire blight has spread through most of the pome fruit growing regions of the world, the importance of blight resistant cultivars has become critical to economic fruit production. Availability of fire blight resistant germplasm is essential before breeding high quality, disease resistant cultivars is possible (Lespinasse and Aldwinckle, 2000). Many pear cultivars have been evaluated and characterized for their response to *Erwinia amylovora*, either following artificial inoculation or natural infection (Lespinasse and Aldwinckle, 2000; Reimer, 1925; van der Zwet and Keil, 1979; van der Zwet and Beer, 1995). The same cultivar may be variously categorized as either resistant or susceptible depending on the type of assay, the isolate of the pathogen or the geographic location where the evaluation took place. Pear cultivars and rootstocks that are consistently reported as moderately to highly resistant in the literature or through personal communications are flagged in the NCGR database and a catalog of these accessions is

available (NCGR, 2007). More than 160 fire blight resistant pear clones are available at the Corvallis genebank including 22 Asian cultivars, 78 European and hybrid cultivars and 61 rootstock or species clones (Table 3).

In their review of the fire blight host literature, van der Zwet and Kiel (1979) do not note any *Cydonia* clones resistant to the disease. Quince cultivars are as susceptible to fire blight as the most susceptible apple and pear cultivars (van der Zwet and Keil, 1979). Quince rootstock clones are also very susceptible (Lespinasse and Aldwinckle, 2000; van der Zwet and Beer, 1995). Several fire blight resistant quince fruit cultivars were recently developed by breeding efforts in Bulgaria (S. Bobev, pers. commun.). With the recent expansion of *Cydonia* germplasm available at the USDA genebank, and the evidence from Bulgaria that fire blight resistance is present in this genus, the likelihood of finding resistance in genebank accessions is very high.

CONCLUSION

In western Oregon's Willamette Valley, temperatures are normally below the threshold necessary for spread of fire blight during *Cydonia* and *Pyrus* bloom periods, and the weather is dry in the summer, making NCGR-Corvallis an ideal location to preserve these living germplasm collections for future generations. Catalogs, links to images, evaluation data and other useful quince and pear genetic resource information is available at the genebank website (Postman and Hummer, 2006). Scions and seeds are freely exchanged with researchers around the world in compliance with quarantine regulations and restrictions of the United States and recipient countries.

Literature Cited

Bassil, N.V., Neou, C. and Postman, J.D. 2005. Pyrus microsatellite markers developed from genbank sequences. Acta Hort. 671:289–292.

Bassil, N.V., Hummer, K.E. and Postman, J.D. 2006. Microsatellites are used to examine apple and pear identities and genetic relationships (abstract). HortScience. 41(4):993.

Bell, R.L. 1990. Pears (*Pyrus*). Acta Hort. 290:657–697.

Bell, R.L., Quamme, H.A., Layne, R.E.C. and Skirvin, R. 1996. Pears. p.441–514. In: J. Janick and J.N. Moore (eds.), Fruit Breeding, Vol. 1, Tree and Tropical Fruits. John Wiley & Sons, Inc.

Lespinasse, Y. and Aldwinkle, H.S. 2000. Breeding for resistance to fire blight. p.253–273. In J.L. Vanneste (ed.), Fire Blight: The disease and Its Causative Agent, *Erwinia amylovora*. CABI Publishing.

NCGR. 2007. NCGR-Corvallis *Pyrus* catalog: fire blight resistant genotypes. http://www.ars-grin.gov/cor/catalogs/pyrblres.html. Accessed 10/2007.

NPGS. 2007a. Summary statistics for the NPGS *Cydonia* collection by country of origin. http://www.ars-grin.gov/cgi-bin/npgs/html/stats/genusgeo.pl?Cydonia. Accessed 09/2007.

NPGS. 2007b. Summary statistics for the NPGS *Pyrus* collection by country of origin. http://www.ars-grin.gov/cgi-bin/npgs/html/stats/genusgeo.pl?Pyrus. Accessed 09/2007.

Postman, J.D. 1997. Quince. p.633–634. In: The Brooks and Olmo Register of Fruit & Nut Varieties, third edition, ASHS Press. Alexandria, Virginia.

Postman, J.D. and Sugar, D. 2002. Elimination of viruses from the USDA *Pyrus* germplasm collection. Acta Hort. 596:529–530.

Postman, J.D. and Hummer, K.E. 2006. National Clonal Germplasm Repository – Corvallis, Oregon. http://www.ars.usda.gov/pwa/corvallis/ncgr. Accessed 10/2007.

Postman, J., Hummer, K., Stover, E., Krueger, R., Forsline, P., Grauke, L.J., Zee, F., Ayala-Silva, T. and Irish, B. 2006. Fruit and nut Genebanks in the US National Plant Germplasm System. HortScience 41(5):1188–1194.

Postman, J. 2008. World *Pyrus* collection at USDA genebank in Corvallis, Oregon. Acta Hort. (in press).

Reed, B.M., Engelmann, F., Dulloo, E. and Engels, J. 2004. Technical guidelines for the

management of field and in vitro germplasm collections. In: Management of field and in vitro germplasm collections. Intl. Plant Genetic Resources Institute.
Reimer, F.C. 1925. Blight resistance in pears and characteristics of pear species and stocks. Oregon Agricultural Collece Experiment Station Bulletin 214:99.
van der Zwet, T. and Keil, H.L. 1979. Fire Blight: A bacterial disease of Rosaceous plants. U.S. Dept. of Agriculture, Agriculture Handbook 510:200.
van der Zwet, T. and Beer, S.V. 1995. Fire Blight – Its Nature, Prevention, and Control: A practical guide to integrated disease management. U.S. Dept. of Agriculture Information Bulletin No. 631:97.
Vavilov, N.I. 1994. Origin and geography of cultivated plants. D. Love (translator). Cambridge Univ. Press. Cambridge, England.
Volk, G.M., Richards, C.M., Henk, A.D., Reilley, A.A., Bassil, N.V. and Postman, J.D. 2006. Diversity of wild *Pyrus communis* based on microsatellite analyses. J. Amer. Soc. Hort. Sci. 131(3):408–417.

Tables

Table 1. USDA National Plant Germplasm System *Cydonia* holdings by origin (NPGS 2007a).

Country	Accessions	Species
Albania	1	1
Armenia	12	1
France	7	1
Georgia	8	1
Germany	7	1
Ireland	1	1
Poland	9	1
Russia	15	1
Turkey	9	1
Turkmenistan	16	1
Ukraine	4	1
United Kingdom	12	1
United States	36	1
Uzbekistan	1	1
Yugoslavia	2	1

Table 2. USDA National Plant Germplasm System *Pyrus* holdings by origin (NPGS 2007b).

Country	Accessions	Species	Country	Accessions	Species
Afghanistan	3	3	Morocco	6	3
Albania	7	3	Nepal	15	4
Armenia	50	7	Netherlands	8	3
Asia	2	2	Norway	1	1
Australia	21	6	Pakistan	37	5
Belgium	51	1	Poland	24	5
Bulgaria	8	2	Portugal	3	1
Canada	43	6	Romania	34	4
China	118	11	Russia	63	14
Czech Republic	29	4	South Africa	10	2
Denmark	3	1	Spain	2	1
Estonia	10	1	Sweden	6	2
Former Sov.Union	27	5	Switzerland	6	2
France	181	7	Syria	4	1
Georgia	37	4	Taiwan	4	1
Germany	15	1	Tajikistan	1	1
Greece	1	1	Tunisia	7	1
Hungary	8	4	Turkey	49	5
India	30	4	Turkmenistan	16	1
Iran	3	2	Ukraine	3	1
Israel	3	3	United Kingdom	88	10
Italy	77	5	United States	931	29
Japan	70	6	Unknown	1	1
Kazakhstan	18	6	Uzbekistan	17	11
Korea, South	24	4	Vietnam	1	1
Kyrgyzstan	3	1	Yugoslavia	42	5
Macedonia	31	4			

Table 3. NCGR fire blight resistant pear accessions.

Asian Cultivars
Ba Li Xiang (Ba Li Hsiang)
Cheih Li
Da Tou Huang (Ta Tau Huang)
Harbin
Hawaii
Huangxianshui Li (Huang Hsing Sui Li)
Hung Li
Lao Suan Li (Lo Suan Li)
Man Yuan Xiang (Man Yuan Hsiang)
Mien Suan Li
Okolo
Pai Li
Seuri Li
Shinko
Singo
Suan Li
Tang Li
Tse Li
Tsu Li
Tsu Li No. 2
Xiangshui Li (Hsiang Sui-Li)
Ya Li
European & Hybrid Cultivars
Ames
Ayer
Ayers
Bantam
Barillet Deschamp
Burkett
Campas No.1
Campas No.2
Canner (Waite?)
Carrick
Cayuga
Cincincis
Dabney
Dixie
Douglas
Duchesse Bronzee
Duchesse d'Angouleme
Duchesse d'Angouleme Bronzee
Early Harvest
El Dorado
Estella
Eureka
Farmingdale
Flordahome
Garber
Good Christian
Greisa No.1
H 6831/1.12
Harrow Delight
Harrow Sweet (HW 609)
Higdon
Honeysweet

Hood
Hoskins
HW 600
HW 601
Kieffer
Krylov
Lemon
Lincoln
Longworth
Luscious
Mac
Magness
Manning-Miller
Maxine
Merricourt
Miney
Mississippi US 3-10-5
Moe
Monterrey
Mooers
Moonglow
Morgan
NY 10262
NY 10353
NY 10355
Old Home
Olia
Orel No. 15
Orient
Pineapple
Pontotoc
Potomac
Richard Peters
Riehl Best
Saint Andre
Seckel
Snyder
Sodak
Southworth
Sucre Verte
Sudduth (=Burkett)
Tennessee
Tyson
Waite (Canner)
Warner
Warren
Ornamental Cultivars
Autumn Blaze (P. calleryana)
Chanticleer (P. calleryana)
Rootstock & Species Selections
Burkett x P. betulifolia
OH 20 (Old Home sdlg.)
OH 50 (Old Home sdlg.)
OHxF 4
OHxF 5
OHxF 18

OHxF 29
OHxF 40
OHxF 69
OHxF 97
OHxF 101
OHxF 109
OHxF 112
OHxF 130
OHxF 132
OHxF 198
OHxF 217
OHxF 230
OHxF 259
OHxF 261
OHxF 266
OHxF 267
OHxF 282
OHxF 288
OHxF 319
OHxF 333
OHxF 377
Old Home x P. betulifolia-1
Old Home x P. betulifolia-1
P. amygdaliformis 639.001 - Greece
P. betulifolia 1311.001
P. betulifolia x P. calleryana-5
P. betulifolia-1 x P-12
P. betulifolia-1 x P-79
P. betulifolia-2 x Farmingdale
P. betulifolia-2 x P. betulifolia-1
P. betulifolia-2 x P-12
P. calleryana 663.001
P. calleryana 666.001
P. calleryana OSU-2
P. calleryana OSU-3
P. calleryana OSU-5
P. calleryana OSU-6
P. calleryana OSU-7
P. calleryana OSU-8
P. calleryana OSU-9
P. communis 693.001 - Turkey (Olez 5)
P. communis subsp. caucasica Mag 1
P. communis subsp. caucasica Mag 5
P. elaeagrifolia 770.001
P. elaeagrifolia Olez 2 - Turkey
P. koehnei 818.001
P. nivalis P-91
P-12 (P. communis rootstock selection)
P-18 (Oregon 18 - P. communis selection)
P-61 (P. communis rootstock selection)
P-70 (P. communis rootstock selection)
P-79 (P. communis rootstock selection)
P-87 (P. communis rootstock selection)
Variolosa (P. pashia hyb.)
W-1 (P. communis rootstock selection)